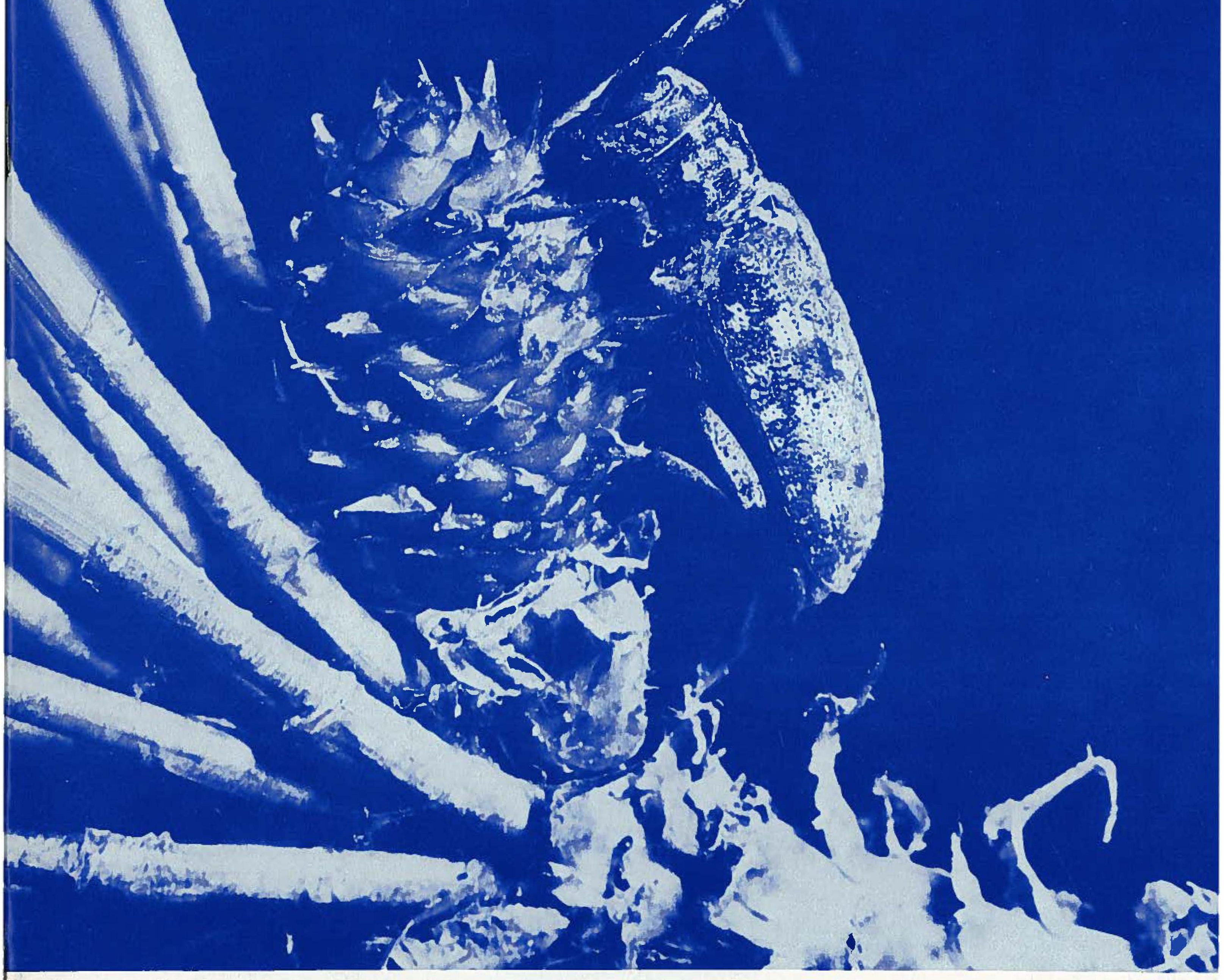
Texas Forest Pest Activity 1978-1979
and
Forest Pest Control Section Biennial Report



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TEXAS FOREST SERVICE

A Part of

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Forest Pest Activity Synopsis

For the first time in 20 years, the southern pine beetle (SPB) subsided from outbreak levels. During 1978, and particularly in 1979, very few SPB infestations were reported throughout East Texas. In their stead, a variety of defoliating insects appeared in local and regional outbreaks. A cankerworm and the variable oak leaf caterpillar were abundant on hardwoods. A little-known looper species — *Anacamptodes vellivolata* — became abundant in native pine stands during 1978. These loopers defoliated several thousand acres of shortleaf pine but the outbreak lasted only one summer. Texas leaf-cutting ants posed problems in many areas of central East Texas where colonies defoliated numerous young pine plantations in 1978 and 1979.

Cover photo:
Sawyer beetle, *Monochamus carolinensis*, feeding on loblolly pine conelet, Kirbyville, Texas. Photo by R. F. Billings.

Texas Forest Pest Activity 1978-79 and Forest Pest Control Section Biennial Report

With Cooperation From Private Forest Industry and National Forests in Texas

TEXAS FOREST SERVICE
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Introduction

The Forest Pest Control Section of the Texas Forest Service is responsible for monitoring pest activity on 12 million acres of state and private forest lands in East Texas. The Section also conducts applied research on major forest pests, primarily on pine bark beetles and seed orchard insects. Every two years, a status report summarizes recent pest problems and documents damage to forest resources caused by insects and diseases. This report includes a biennial synopsis of research findings, personnel changes and recent developments concerning the Pest Control Section. Much of the information on pest activity and damage has been provided by Texas Forest Service foresters, private forest industry and the National Forests in Texas. Their cooperation is gratefully acknowledged.

Texas Forest Pest Activity 1978 - 1979

Southern Pine Beetle (SPB)

Southwide Infestation Status

During 1978, populations of the southern pine beetle, *Dendroctonus frontalis*, increased from very low levels to epidemic proportions in western Georgia, the eastern Piedmont of Alabama, and the east-central counties of Mississippi. During 1979, SPB infestations appeared throughout Alabama, Georgia, Mississippi and into areas of North and South Carolina. By early 1980, SPB had reportedly killed 235,372,000 board feet of sawtimber and 1,292,919 cords of pulpwood in these states. With the mild winter of 1979-1980, the SPB epidemic is expected to continue in these states. Beetle activity in Louisiana and Texas, however, remained at extremely low levels throughout 1978 and 1979.

SPB Status in East Texas 1978-1979

Following sporadic outbreaks from the late 1800's until the late 1950's, Texas endured a continuous 20-year period (1958-1977) during which damage by southern pine beetle occurred at moderate to extremely high levels. The worst outbreak on record occurred in 1976 when nearly 11,000 spots were reported. However, beetle populations collapsed the last quarter of 1977 and very little activity has occurred since then (Table 1). Only 36 confirmed SPB spots were reported in 1978 throughout East Texas. Of these, 31 became inactive with no control needed, two were controlled by salvage, and two by cut-and-leave. One spot remained marginally active until early 1979. This lone active spot was a research area near Conroe in Montgomery County. Beetles killed an estimated 45,000 cu. ft. of timber in 1978. Approximately 40 percent of this volume was pulpwood. Because many spots were inactive, only 11 percent of the killed volume was salvaged.

In 1979 only two SPB spots were found throughout East Texas. One spot located in Sabine County received no control because it became inactive. The other spot, located in Tyler County, was salvaged. The beetles killed a total of 6,000 cu. ft. of pine timber of which 30 percent was salvaged. All but 300 cu. ft. of the volume was sawtimber. This level of infestation is the lowest recorded since 1957.

Table 1. Estimated volume of pine timber killed by the southern pine beetle in East Texas since 1958.

Year	Sawlogs (M bd. ft.)	Pulpwood (cords)	Total (M cu. ft.)
1958	500	0	84
1959	2,500	2,500	598
1960	8,000	8,000	1,912
1961	17,887	24,000	4,715
1962	93,043	111,110	23,538
1963	4,084	1,920	820
1964	2,501	1,420	520
1965	3,797	7,743	1,192
1966	6,256	6,930	1,544
1967	7,194	8,566	1,818
1968	17,644	22,037	4,533
1969	7,341	7,478	1,760
1970	4,318	14,730	1,782
1971	3,872	66,933	5,466
1972	24,710	50,393	7,755
1973	38,595	45,983	9,900
1974	50,489	52,622	12,383
1975	45,187	32,087	9,951
1976	213,552	215,128	51,619
1977	42,631	66,879	12,088
1978*	162	242	45
1979*	36	4	6
TOTAL	594,299	746,705	154,029

*Excludes volume killed on National Forests or Big Thicket National Preserve units.

Other Bark Beetles

In the pine forests of East Texas, the southern pine beetle usually causes the greatest economic damage. However, four other bark beetle species — the black turpentine beetle *(Dendroctonus terebrans)* and three species of engraver beetles *(Ips avulsus, I. grandicollis,* and *I. calligraphus)* also attack and kill pines. During 1978 and 1979 very little activity from these bark beetles was reported. The black turpentine beetle occurs throughout East Texas, but activity worth noting was reported only from Harrison, Marion, Bowie, Nacogdoches and Jasper counties. The largest infestation contained 50 trees in Bowie County.

Engraver beetles caused local problems in Camp, Titus, Franklin, Morris, Upshur, Wood, Jasper, Montgomery, Orange, Bowie, Marion, Harrison, Newton and Hardin counties. The largest infestation covered about five acres of pine in Montgomery County. A new insecticide, Dursban 4E®, is now registered by the Environmental Protection Agency (EPA) for both prevention and direct control of southern pine bark beetles.[1]

[1]Use of commercial trade names throughout this publication is for identification only and does not imply endorsement or approval by the Texas Forest Service.

Defoliators

Populations of defoliating insects during 1978 and 1979 increased over most of East Texas compared to the previous 4-6 years. Town ants and a variety of lepidopterous defoliators were most abundant.

Town Ants

Although not the most wide-spread, the Texas leaf-cutting ant or town ant *(Atta texana)* probably caused the most damage and concern (Figure 1). These large red ants, which do not sting, are a serious problem to young pine seedlings. The ants cut and carry green foliage underground to culture a fungus. This fungus is their food supply. During the winter and early spring, when pine needles are usually the only green foliage available, colonies of leaf-cutting ants may completely defoliate young pine seedlings. Sometimes they may even remove the buds, killing the seedling. Colonies of town ants were abundant in at least 18 East Texas counties during 1978 and 1979 including Upshur, Wood, Harrison, Anderson, Cherokee, Smith, Rusk, Houston, Tyler, Jasper, Trinity, Polk, Panola, Newton, Sabine, Hardin, Angelina and Nacogdoches. In several instances 10-20 acres were affected by a few closely associated towns. One industry forester reported over 100,000 seedlings killed by these ants.

In the past these ants were easily and effectively controlled with a bait laced with the insecticide mirex. However, the EPA banned all uses of mirex after December 1978, eliminating the forester's most practical control for this pest. Prior to the ban, mirex was applied over large areas from the air for control of the imported fire ant. Although controversial, this practice apparently helped to keep town ant populations at low levels. Two

Figure 1. Entomologist Joe Pase examines large colony of Texas leaf-cutting ants in Tyler County.

other insecticides — methyl bromide and sodium cyanide — are still registered for town ant control. But both are more toxic to mammals and more difficult to apply under field conditions than mirex.

Shortleaf Pine Looper

In May 1978, an industry forester reported defoliation of shortleaf pine stands in Cherokee County near Fastrill where state highway 294 crosses the Neches River.

A field check revealed the damage was caused by geometrid or looper larvae. The larvae were reared to adults and identified as *Anacamptodes vellivolata* (Hulst) (Figure 2 a,b).

Reports from industry and Texas Forest Service foresters as well as surveys by Pest Control personnel identified 11 areas of about 50,000 to 60,000 acres where this looper had fed (Figure 2c). Damage was light to moderate in all areas with the exception of about 1,500 to 2,000 acres in Cherokee and Rusk counties where defoliation was heavy (>75 percent of foliage consumed). Some trees weakened by total defoliation were later attacked and killed by *Ips* beetles; however, this mortality was negligible.

The larvae completed feeding by July 1978 and pupated in the ground litter just above mineral soil. Litter searches throughout the summer revealed high pupal mortality, presumably due to predation, parasitism and very dry soil conditions. Larvae and adults of the carabid predator, commonly called the caterpillar hunter *(Calosoma scrutator)*, were abundant in looper-infested areas. Also parasites emerged from many pupae that were brought into the lab as last instar larvae. A subsequent generation (fall 1978 or spring 1979) never developed to sizeable numbers. In March

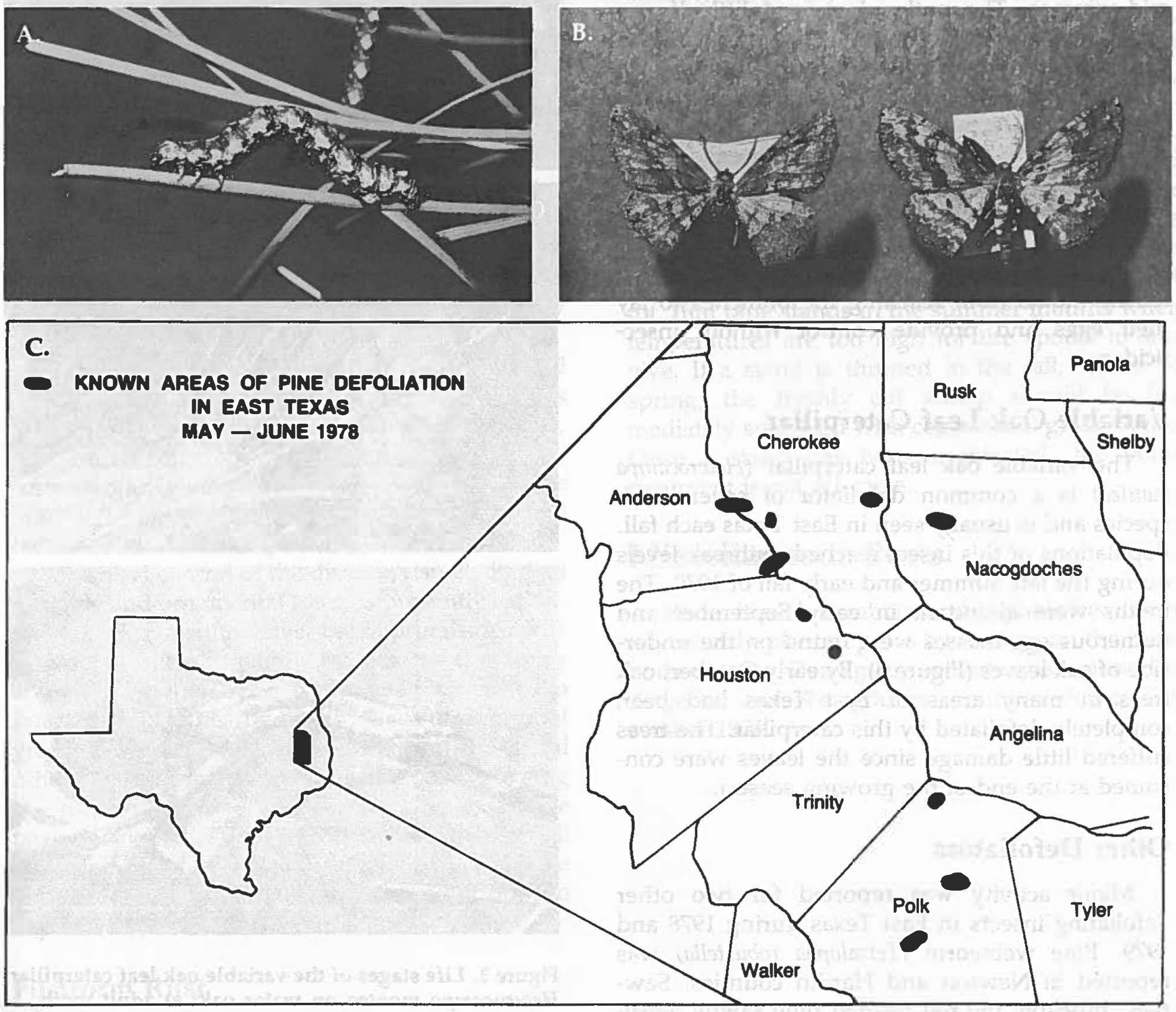


Figure 2. The shortleaf pine looper, *Anacamptodes vellivolata*: a) larva, b) adult moths and c) known areas of pine defoliation during 1978 in East Texas.

1979, two looper adults were collected in a light trap near Kirbyville in Jasper County. Since then no evidence of their presence has been reported. Apparently, the population collapsed after the summer of 1978 as a result of natural controls. This was the first recorded outbreak of this looper in Texas.

Cankerworms

Cankerworms (family Geometridae) were very widespread over a large portion of Central Texas in the spring of 1979. At least two species were involved in the outbreak. Larvae fed predominately on oaks, defoliating trees over an estimated 27 million acres. Defoliation was reported in Waco, Palestine, Huntsville, Corpus Christi, Kerrville, Austin, San Antonio and most places in between. Although the loss of foliage appeared quite spectular during late spring, the trees leafed out again by mid-summer. The outbreak caused little if any impact other than the nuisance of droppings and larvae in and around urban and rural homes.

Larvae of the cankerworm pupate in the ground. Female moths cannot fly so they must crawl up the tree's trunk in order to lay eggs on the branches. To control cankerworms in residential areas, apply a band of sticky material (such as Tanglefoot®) around the trunks of trees in early spring before the moths emerge. This will prevent female moths from reaching the branches to lay their eggs and provide control without insecticides.

Variable Oak Leaf Caterpillar

The variable oak leaf caterpillar (*Heterocampa manteo*) is a common defoliator of several oak species and is usually seen in East Texas each fall. Populations of this insect reached outbreak levels during the late summer and early fall of 1979. The moths were abundant in early September and numerous egg masses were found on the underside of oak leaves (Figure 3). By early October, oak trees in many areas of East Texas had been completely defoliated by this caterpillar. The trees suffered little damage since the leaves were consumed at the end of the growing season.

Other Defoliators

Minor activity was reported for two other defoliating insects in East Texas during 1978 and 1979. Pine webworm (*Tetralopha robustella*) was reported in Newton and Hardin counties. Sawflies, probably the red headed pine sawfly *Neodiprion lecontei*, were reported in Newton County with "more than usual" activity occurring in

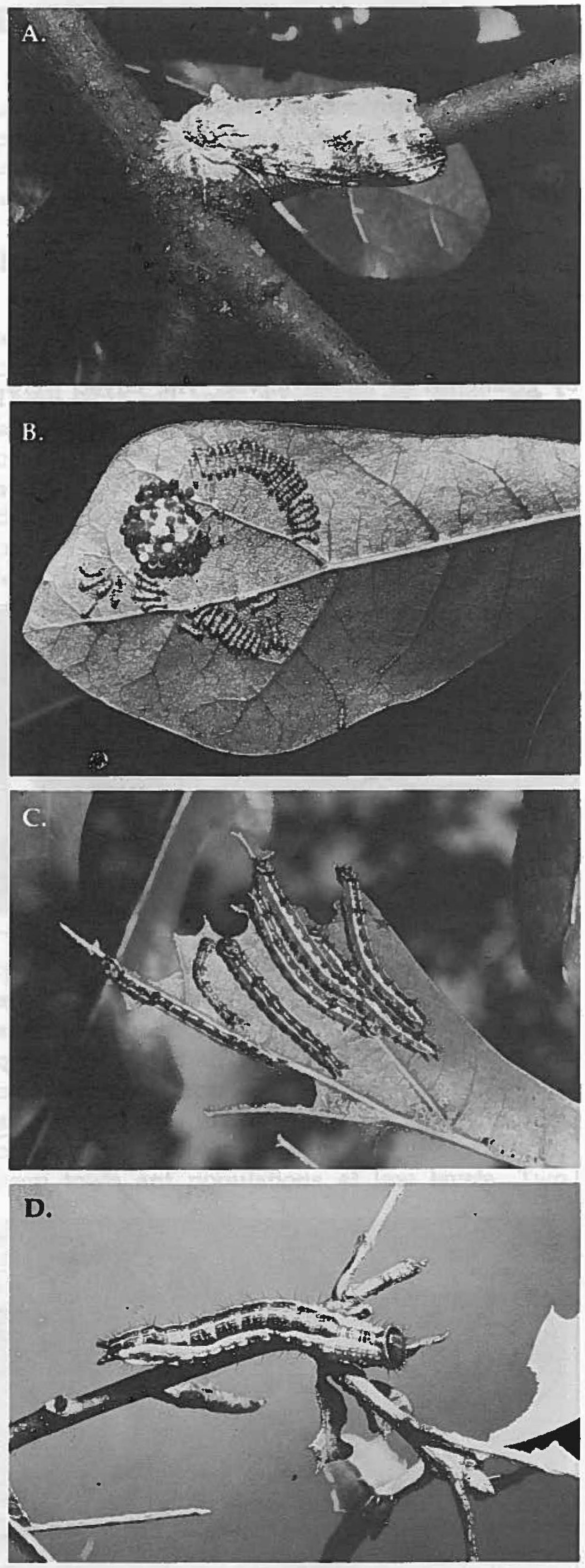


Figure 3. Life stages of the variable oak leaf caterpillar, *Heterocampa manteo* on water oak: a) adult moth, b) egg cluster and young larvae on underside of leaf, c) mid-size larvae devouring leaf tissue and d) full-grown larva.

Sabine, San Augustine, Shelby and Panola counties.

Tip Moths

The Nantucket pine tip moth (*Rhyacionia frustrana*) occurs throughout the pine region of East Texas each year. This insect normally attacks pine trees up to about ten feet in height, killing terminals and branch tips. They rarely kill a tree, but repeated attacks may lead to reduced growth and poor form. No reports of severe tip moth infestations were received.

Diseases

Oak wilt has killed large numbers of oaks in Central Texas and represents a major disease problem in this region of the state. Two other diseases — fusiform rust and annosus root rot — are causing increasing concern in East Texas.

Oak Wilt

The oak wilt fungus (*Ceratocystis fagacearum*) was isolated for the first time in Texas from live oaks in the Kerrville area (Kerr County). This disease occurs in conjunction with several other fungi in dying oaks, making its presence difficult to confirm. The disease may cause an oak tree to die slowly over a period of several years or rapidly in four to six weeks.

Pathologists once believed that oak wilt would not survive in Texas because warm temperatures would be lethal to the disease. In Central Texas, the disease apparently is dormant during the summer and winter months and becomes active only in the spring and fall when temperatures are favorable for its development.

Chemical control of the disease, usually limited to shade and ornamental trees, is presently experimental. But results have been promising. The disease is spread mainly by insects that carry spores to healthy trees. It also may spread from infected trees to nearby healthy trees through root grafts. Since oak wilt has been present in several other states for many years, restrictions regulating the foreign export of oak lumber and logs have been developed. These restrictions specify that all oak lumber and logs must be free of bark and have a moisture content of less than 20 percent prior to exportation.

Fusiform Rust

Fusiform rust (*Cronartium fusiforme*) has received increased attention recently in East Texas, particularly in slash pine plantations. To complete its life cycle this rust must infect oak before it can infect pine again. It does no damage to oak trees, producing only small eruptions on the lower surface of the leaves in early summer. On pine trees, however, it produces fusiform-shaped galls on the main stem or branches of the tree. Galls on the main stem may kill the tree, cause it to break easily in a wind storm, or render a portion of the stem unmerchantable. Branch galls usually don't harm the tree, but they provide a source of inoculum that may increase the incidence of rust in the area. Fusiform rust is present in all areas of East Texas. But infections appear to be heaviest in the southeastern portion of the state, particularly in Newton, Tyler and Hardin counties.

Annosus Root Rot

Annosus root rot (*Heterobasidion annosum = Fomes annosus*) for many years was considered a problem in and around Nacogdoches County. This disease, most common in thinned pine stands, caused significant timber mortality in Titus, Morris, Camp, Upshur, Cherokee, Smith, Panola, Houston and Marion counties during 1978 and 1979. The airborne fungal spores commonly infect a stand when they land on a freshly-cut stump. Then the fungus grows down and through the roots of the stump to infect healthy neighboring trees through root grafts. To avoid infection from annosus root rot, thin pine stands in the summer months when temperatures are too high for the spores to survive. If a stand is thinned in the fall, winter or spring, the freshly cut stump should be immediately sprinkled with commercial grade borax. Once a stand has become infected, the borax treatment is not effective.

Miscellaneous Pests

Rodents such as rabbits and gophers frequently kill recently-planted pines by feeding on the bark, buds or roots. Damage by rodents was reported in Angelina and Nacogdoches counties during December 1979.

Research and Applications

The Forest Pest Control Section conducts applied research on major pest problems. Principally, these include cone and seed insects in seed orchards and pine bark beetles. Some research projects have recently been completed and results published, while others remain in progress. Summaries of the more pertinent findings are presented below. Copies of published articles and circulars are available from the Pest Control Section, Texas Forest Service, P.O. Box 310, Lufkin, Texas 75901.

Cone and Seed Insect Research

Seedbugs and coneworms are the most important insect pests of southern pine seed orchards. Adults and nymphs of seedbugs (*Leptoglossus corculus* and *Tetyra bipunctata*) cause damage by penetrating the cone scales of both conelets and cones and removing the contents of developing ovules and fully developed seed with their piercing-sucking mouth parts. Ovules damaged by seedbugs cease to develop and often the entire conelet aborts. Coneworms (larvae of *Dioryctria* spp.) feed on the interior portions of conelets and cones, usually killing the entire structure.

Research on cone and seed insects in Texas Forest Service seed orchards during 1978-1979 focused on three areas: (1) biology and seasonal activities of seedbugs and coneworms, (2) impact of insects on cone and seed yields and (3) evaluations of operational and experimental insecticide applications.

Seasonal Activities of the Shieldback Pine Seedbug

The shieldback pine seedbug, *Tetyra bipunctata*, is abundant in pine seed orchards in East Texas (Figure 4). Yet relatively little is known about this

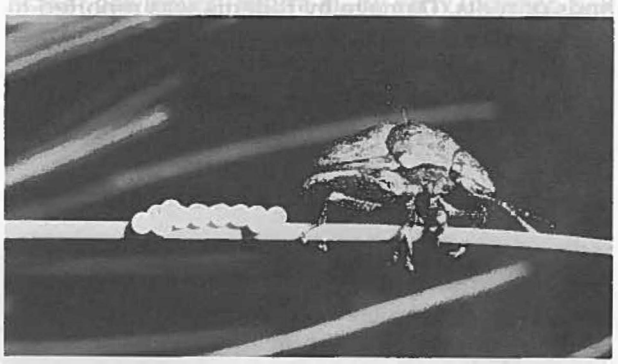


Figure 4. Adult and eggs of the shieldback pine seedbug, *Tetyra bipunctata*, an economic pest of southern pine seed orchards.

insect. The Pest Control Section initiated studies during 1978 to explore the seasonal activities and biology of this pest.

Inspection of foliage, bark and soil litter in Texas Forest Service seed orchards at Magnolia Springs during the 1977-78 winter indicated that *Tetyra bipunctata* spends the winter as an adult primarily under the needle litter just above the mineral soil. More than 100 overwintering adults were located near the trunks of trees; none were found outside the drip lines of the tree crowns. Adults were observed to emerge from their overwintering sites from mid-March to early April in 1978.

Seasonal activities of *T. bipunctata* were further investigated through laboratory and field rearing cages, monthly dissections of field collected females to follow ovary development and through periodic field observations. Shieldback pine seedbugs were difficult to find in seed orchards shortly after they emerged from overwintering sites. However, numerous adults were found concealed among male catkins in seed orchard trees in late April 1978; and many others were present inside old unharvested cones and in the forks of small branches in May. Throughout the remainder of the summer, adults were observed and collected from branches and from cones as they fed on developing seeds.

Seedbug egg-laying habits were monitored in laboratory and field cages. Also, monthly observations were made of the ovary development of field-collected females. Mating commenced in late-June and oviposition occurred from mid-July through mid-September (Figure 5). Eggs are usually laid on pine needles in groups of 14, in two parallel rows (see Figure 4).

Among 235 eggs collected on loblolly seed orchard trees at Magnolia Springs, nearly 32 percent were parasitized by a small wasp of the Scelionidae family, possibly *Trissolcus* sp.

During the winter of 1978-1979, unlike the previous winter, no adult seedbugs were found in soil samples or in crowns of trees at Magnolia Springs and Fastrill. The conclusion was that the population of shieldback pine seedbugs either collapsed or migrated out of the area during the fall of 1978. In the Magnolia Springs seed orchards during 1979, shieldback pine seedbugs were not found until late summer when a few were observed in a loblolly orchard not treated with insecticide. Low levels of seedbug damage among the 1979 seed from Magnolia Springs support these observations.

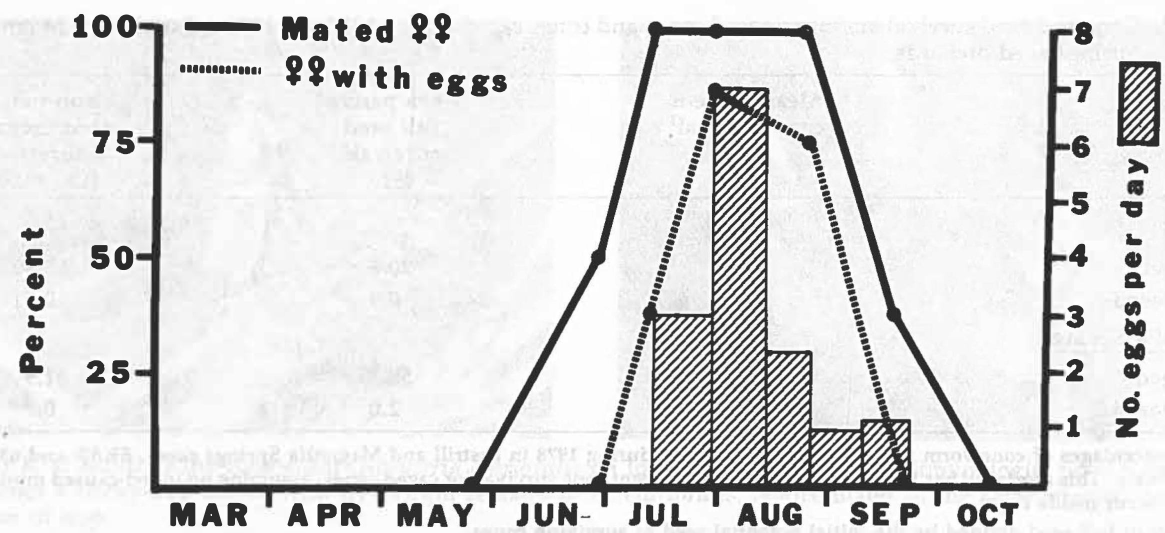


Figure 5. Seasonal trends in the biology of the shieldback pine seedbug showing the percent of field-collected females that had mated, the percent with developed eggs and the number of eggs deposited per day in field cages during 1978 at Magnolia Springs, Texas.

Seedbug Damage Assessment — 1977 and 1978 Caging Studies

In a study initiated in May 1977 in loblolly pine seed orchards at Magnolia Springs and at Fastrill, cones and conelets were enclosed in screen cages (Figure 6). To document the types of damage seedbugs cause, adults of the shieldback pine seedbug *Tetyra bipunctata* were introduced into 19 of the cages in late August 1977 and removed at cone harvest. These adults damaged approximately one seed per bug per day in these cages, but caused no apparent conelet abortion. Due to heavy damage by coneworms inside the cages mostly during 1978, it remained uncertain whether these adults had fed on and destroyed ovules in caged conelets. However, analysis of 31 surviving cones which were exposed in the conelet stage to adult seedbugs inside cages revealed only a slight increase in first year aborted ovules when compared with 11 caged cones not exposed to seedbugs.

Another caging study was conducted on loblolly and slash pine seed orchard trees at Magnolia Springs during 1978. Nymphs and adults of *T. bipunctata* were maintained throughout the summer in field cages containing cone and conelet-bearing branches. Coneworms destroyed many of the caged cones in this study also, but analysis of the remaining healthy cones showed that nymphs of *T. bipunctata* apparently contributed to first year aborted ovules in conelets and damaged seed in second year cones. However, there was little evidence that either nymphs or adults caused conelet abortions, second year aborted ovules or empty seeds in cones.

Sample cones and conelets were protected inside cages without seedbugs to measure the extent of damage caused by wild populations of seedbugs to unprotected cone and seed resources. Large differences in cone and seed survival were observed between caged and exposed cones (Table 2). Only two of 97 initially exposed cones at Fastrill remained at cone harvest and each contained only one full seed. Much of this mortality is presumed to be caused by seedbugs. This dramatically illustrates the potential impact insects may have on seed production in southern pine seed orchards particularly in situations where a small cone crop coincides with high populations of both seedbugs and coneworms.

Figure 6. Saran® cage used to rear shieldback pine seedbugs on cones and conelets in the field.

Flight Periods of Coneworm and Seedworm Adults

Light traps located near the Pest Control laboratory in Lufkin and at the Magnolia Springs seed orchard were operated two nights each week from March through November during 1978 and 1979. These traps were used to monitor the seasonal

Table 2. Cone and seed survival among exposed cones and cones caged during 1977 and 1978 at Fastrill and Magnolia Springs seed orchards.

Cone condition	Mean percent cone survival[1] (CE)	Mean percent full seed survival[2] (SE)	Mean percent seed orchard survival (CE × SE)
Fastrill			
Caged	92.3	70.8	65.30
Exposed	1.2	0.9	0.01
Magnolia Springs			
Caged	89.0	58.3	51.9
Exposed	36.8	2.0	0.7

[1]High percentages of coneworm mortality occurred mostly during 1978 in Fastrill and Magnolia Springs cages, 59.8% and 63.3%, respectively. This mortality has been excluded from the percent cone survival for caged cones, assuming no insect-caused mortality should occur inside cages.

[2]Number of full seed divided by the initial potential seed in surviving cones.

occurrence and abundance of four species of coneworms (the southern pine coneworm — *Dioryctria amatella*, the blister coneworm — *D. clarioralis*, the webbing coneworm — *D. disclusa*, and the loblolly pine coneworm — *D. merkeli*) and two species of seedworms (the eastern pine seedworm — *Laspeyresia toreuta*, and the longleaf pine seedworm — *L. ingens*).

Light trap catches show that the peak flight periods of the blister coneworm occur in April, July and September each year (Figure 7). Southern pine coneworm adults (Figure 9a), on the other hand, were collected from April through October, exhibiting no distinct seasonal flight peaks. A few specimens of the loblolly pine coneworm were captured in September and October at Lufkin and Magnolia Springs while occasional adults of the webbing coneworm were collected in early summer only at Magnolia Springs. The eastern pine seedworm and the longleaf pine seedworm both emerge in early summer, May through June. The eastern pine seedworm appears to be the more prevalent species in East Texas, as the longleaf pine seedworm has been captured only at Magnolia Springs. Peak emergence of the eastern pine seedworm follows that of the longleaf pine seedworm.

Blister Coneworm Pheromone Study

In the summer of 1979, the Pest Control Section initiated a study to identify the pheromone compounds of the blister coneworm *Dioryctria clarioralis* (Figure 8a). Another objective was to investigate the possibility of using pheromones for monitoring seasonal flight periods of this coneworm species as a means to improve the timing of insecticide applications.

In preliminary field tests, sticky traps (Figure 8b) baited with newly-emerged, unmated females captured more than 550 males, while empty check traps captured none. This demonstrated that female blister coneworms attract males, probably by means of a species-specific attractant or pheromone. To pursue this aspect, a blister coneworm laboratory colony was established on artificial diet. To date, four generations have been successfully reared for use in field and laboratory experiments.

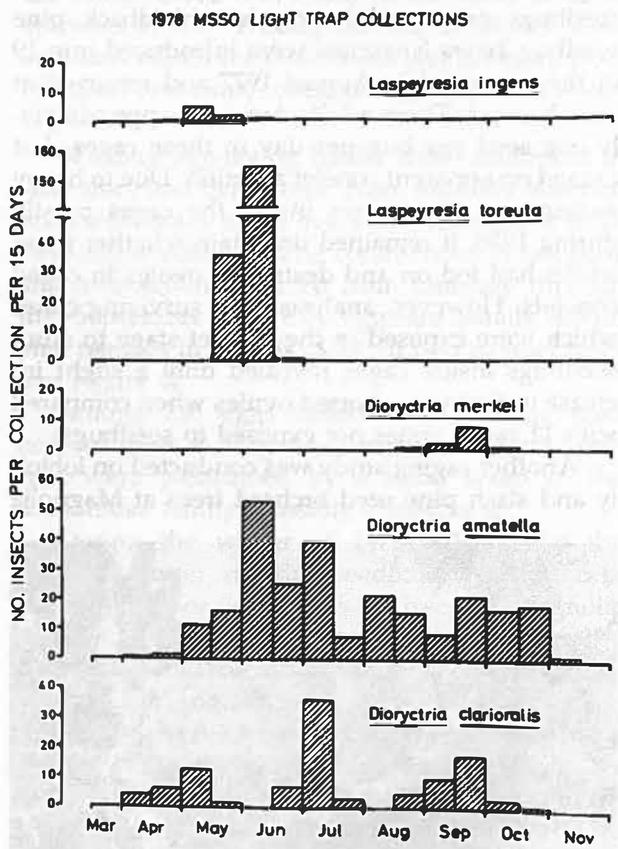
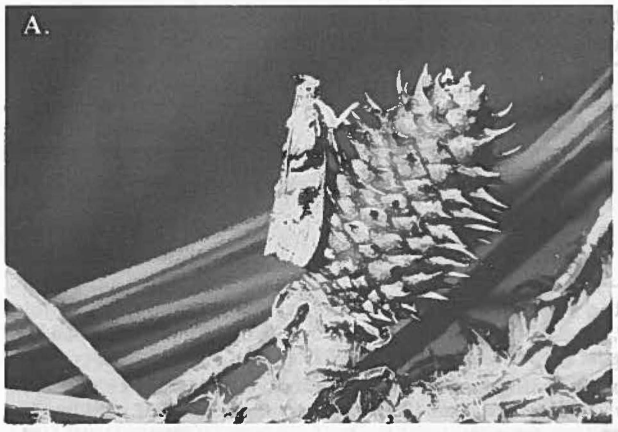


Figure 7. Numbers of coneworms and seedworms collected in a light trap located at the Magnolia Springs seed orchard during 1978.



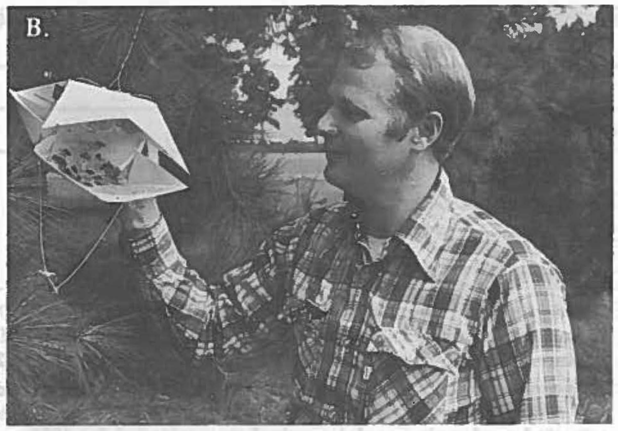


Figure 8. a) Adult of the coneworm *Dioryctria clarioralis* on loblolly pine conelet. b) Entomologist Scott Cameron examines a sticky-trap baited with live virgin females of *D. clarioralis*. Notice males of the same species stuck to bottom of trap.

Live males and extracts from females obtained from this laboratory culture have been sent to Dr. Wendel Roelofs, chemist with the N.Y. Agricultural Experiment Station, Cornell University. He is attempting to isolate and identify the pheromone compounds. Candidate synthetic compounds provided by Dr. Roelofs will be tested for attractancy in the field during 1980. Other researchers in Georgia are investigating the pheromone of the southern pine coneworm, *D. amatella*. If successful, the various pheromone studies will lead to a simplified method of monitoring the seasonal activities of these important cone-destroying insects and perhaps even to an alternative to insecticides for control.

Comparison of Furadan®and Guthion® in Operational Applications

Only two insecticides — Furadan (carbofuran) and Guthion (azinphosmethyl) are presently registered by the EPA for cone and seed insect control. Under experimental conditions, these insecticides proved effective for reducing seedbug and coneworm damage and both are now being used extensively in southern pine seed orchards. Insect control under operational conditions, however, has been inconsistent; substantial losses have occurred in seed orchards treated with these insecticides. A study was initiated in 1978 in a drought hardy loblolly orchard at Magnolia Springs to evaluate and compare the effectiveness of Guthion and Furadan when applied under Texas conditions and with existing application equipment.

Furadan was applied once in March in 1978 and 1979 at eight ounces per inch of diameter with the John Deere 1500 Powr-till Seeder®. Guthion was applied with a Span Spray® Model 100 in a block of the same orchard adjacent to the Furadan treated rows. A 1 percent dilution of Guthion 2L was applied at the rate of two gallons per tree. In both 1978 and 1979, two sets of five rows, separated by four buffer rows, received five and three applications of Guthion, respectively. Treatments were initiated in late April and repeated at approximately monthly intervals.

Several variables were selected to evaluate the effectiveness of these treatments for insect control. These included: 1978 cone crop survival and coneworm damage, 1978-1979 cone crop survival and coneworm damage, 1979 cone survival and 1978 and 1979 seedbug-damaged seed. These factors were monitored on two ramets in each of five clones in each treatment.

The 1978 cone crop was relatively small in the drought-hardy loblolly orchard and percent cone mortality was high (Table 3). All three insecticide treatments substantially increased survival of the 1979 cone crop as compared to the check. Furadan provided better control than either three or five applications of Guthion.

Damage to the 1978-1979 cone crop and the 1979 conelets was relatively light. The mean survival was slightly higher on the trees treated with Furadan and five applications of Guthion than on the check trees or those receiving three applications of Guthion. Observed differences among treatments, however, were not statistically significant ($P>0.05$).

A comparison of mean percent coneworm and seedbug damage is presented by treatment in Table 4. Significant differences between treatments ($P<0.01$) in percent coneworm and seedbug damage were observed for the 1978 cone crop, but not for the 1979 cone crop, presumably because damage levels were relatively low in 1979 even on untreated trees.

Five applications of Guthion generally provided better protection for conelets, cones and seeds than three applications. However, neither

Table 3. Comparison of cone and seed survival on check trees and trees treated with Furadan® and Guthion® in 1978 and 1979 at Magnolia Springs.

Cone crop survival factors[2]	Check	Treatments[1] Furadan	Guthion 3X	Guthion 5X
		-percent-		
Mean percent 1978 cone crop survival	16	72	39	44
Mean percent 1978-1979 cone crop survival	30	42	32	40
Mean percent 1979 conelet survival	89	95	89	95

[1]Furadan applied March 20, 1978, and March 8, 1979; Guthion 3X applied May 1, June 28 and September 21 in 1978 and April 26, July 12 and September 7 in 1979; Guthion 5X applied April 26, May 29, June 28, July 26 and September 21 in 1978 and April 26, no treatments in May and June due to equipment failure, July 12, August 14 and September 7 in 1979.

[2]1978 cone survival × proportion full seed among extracted seed, significant differences between means ($P<0.01$); 1978-1979 conelet and cone survival × seed survival factor (ml/100 cones divided by 742.7 potential ml/100 cones) × proportion full seed among extracted seed; only conelet survival was recorded for 1980 cone crop.

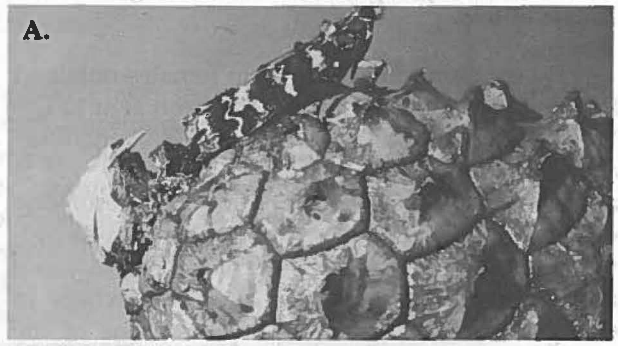
treatment provided excellent insect control. Possible explanations for the relatively poor insect control obtained with three and five applications of Guthion include improper timing of insecticide treatments and poor spray coverage with the Span Sprayer. In 1978, contrary to expectations, more coneworm damage occurred on the trees treated with Guthion five times than on those treated only three times. This discrepancy may be due to differences in distributions of coneworm populations in the two treatment blocks, or to a slight difference in timing of the first application in 1978.

Seedbug damage to the 1978 seed crop was heavy on all except the Furadan treated trees. The nymphs of the southern pine seedbug *(Leptoglossus corculus)* are known to cause substantial conelet abortion. Therefore, one would expect heavy conelet mortality during the same years that southern pine seedbugs cause heavy seed damage. However, conelet mortality (excluding coneworm caused mortality) was only 7.4 percent on the check trees in 1978. Shieldback pine seedbugs *(Tetyra bipunctata)* were very common in the Magnolia Springs seed orchard during 1978 and it is suspected that much of the seedbug damage in 1978 was caused by this insect. Also, the apparent lack of conelet mortality would indicate that, unlike the southern pine seedbug, the shieldback pine seedbug causes little conelet abortion.

Coneworm Damage in Guthion-Treated Orchards

Coneworms *(Dioryctria* spp.) are among the most destructive insect pests in pine seed orchards (Figure 9). From 1977 through 1979, the Pest Control Section monitored levels of coneworm damage at time of cone harvest on 20 ramets in each of three Texas Forest Service seed orchards at Magnolia Springs. Two orchards, the high density slash and drought hardy loblolly orchards, were treated with Guthion four to five times each year.

A.



B.

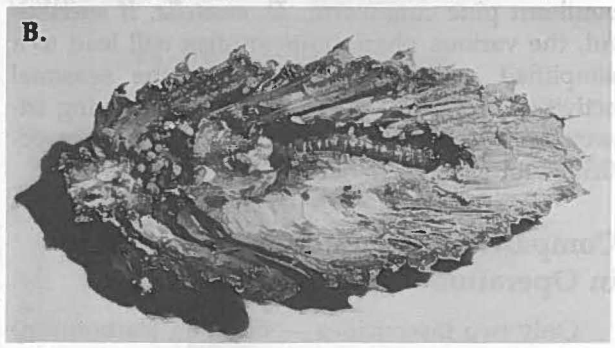


Figure 9. The southern pine coneworm, *Dioryctria amatella*, a major seed orchard pest: a) adult on loblolly cone; b) loblolly cone attacked by a coneworm larva.

A third orchard, the high density loblolly orchard, was left untreated. In 1977 four ramets from each of five clones were randomly selected for sample trees. When possible, the 1977 sample trees also were used in 1978 and 1979 studies.

At harvest each year, total bushels of cones per tree were measured, and then 100 cones were systematically selected from each sample tree to inspect for damage and to measure their volume. From this data, the percent coneworm damage, the mean number of coneworm-damaged cones per ramet, and the mean number of cones per ramet were computed. Findings are summarized by year for all orchards in Table 5 and by orchard for all three years combined in Table 6.

Table 4. Comparison of coneworm and seedbug damage on check trees and trees treated with Furadan®and Guthion®in 1978 and 1979 at Magnolia Springs.

Damage factor	Check	Treatments[1] Furadan	Guthion 3X	Guthion 5X
Mean percent coneworm damage		-percent-		
1978 cones[2]	64.9	16.7	18.1	31.7
1978-79 cones	19.7	8.9	8.7	4.8
Mean percent seedbug damage				
1978 seed[2]	29.6	3.2	33.8	26.4
1979 seed	1.0	0.8	1.0	0.6

[1]See Table 3 for application dates
[2]Significant differences between treatments ($P<0.01$).

Table 5. Yearly summary of average percent coneworm damage, total coneworm-damaged cones and total cones on 20 ramets in three Texas Forest Service seed orchards at Magnolia Springs.

Year	Percent coneworm damage[1]	Total no. of coneworm-damaged cones per ramet[1]	Total cones per ramet[1]
1977	14.0[b]	54.5[b]	462.5[b]
1978	40.3[a]	47.2[b]	123.3[c]
1979	17.3[b]	74.3[a]	575.2[a]

[1]Any two means not having a letter in common are significantly different at the 5% level.

Table 6. Variation between orchards in percent coneworm damage, total coneworm damage and total cones per ramet at cone harvest from 1977-1979 at Magnolia Springs.

Orchard	Percent coneworm damage	Total no. of coneworm-damaged cones per ramet	Total cones per ramet
High density slash[1]	26.8	53.8	251.0
Drought hardy loblolly[1]	18.8	61.8	538.4
High density loblolly[2]	26.8	60.4	368.1

[1]These orchards were treated with five applications of Guthion at monthly intervals, except in 1979 when they were treated only four times.
[2]This orchard received no insecticide appication.

The percent coneworm damage for all orchards combined was significantly higher ($P<0.05$) in 1978 than in either 1977 or 1979. However, the mean number of damaged cones per ramet (total amount of coneworm damage) was lowest in 1978 and significantly higher ($P<0.05$) in 1979 than in 1977 or 1978. This apparent discrepancy is explained by the variation in cone crop sizes. Relatively few cones were available to coneworms in 1978 due to a small cone crop and therefore percent damage was high. In 1979, by contrast, there was a relatively large cone crop and percent coneworm damage was lower. Coneworm population levels in 1979 were similar or even higher than those present in 1978. This conclusion is also supported by light trap catches; the mean numbers of coneworms per collection per 2 week period at the Magnolia Springs orchard were similar in 1978 and 1979.

Considerable coneworm damage was observed in the two orchards treated with Guthion (Table 6). It is questionable whether different orchards within the same seed orchard complex can be validly compared due to possible differences in insect populations. However, it is interesting to note that no significant differences in percent coneworm damage, total coneworm damage per ramet or total cones per ramet were observed between insecticide treated and untreated orchards. This would indicate that the Guthion treatments have provided only limited control of coneworms.

Coneworm larvae apparently spend little time wandering on exposed surfaces before boring into host material. Once within the cones, they are essentially protected from contact insecticides such as Guthion. This fact emphasizes the importance of proper timing of treatments and good spray coverage for the control of this group of insects. It

is likely that a combination of improper timing of spray applications and poor spray coverage are in part responsible for this poor coneworm control.

Evaluation of Two Experimental Insecticides

Each of the two insecticides currently registered for cone and seed insect control has certain drawbacks. Guthion is highly toxic to humans and requires good spray coverage and proper timing of applications to be effective. Furadan is particularly toxic to birds, must be incorporated into the soil and apparently requires proper rainfall patterns to be effective against coneworms. There is a continued need to develop and register new insecticides as alternatives to Furadan and Guthion for insect control in seed orchards.

Laboratory studies conducted by the U.S. Forest Service have shown that several of the new synthetic pyrethrin insecticides were effective against *Dioryctria amatella* and *Leptoglossus corculcus*. These pyrethrin insecticides have the advantages of being relatively safe to use, are effective at low application rates and may remain active over a relatively long time. In a cooperative project directed by the U.S. Forest Service, field tests were conducted during 1979 in seed orchards in Georgia, Louisiana, Mississippi and Texas. The Pest Control Section contributed to this study by applying one concentration of Ambush®and three concentrations of Pydrin®at monthly intervals for five months starting in April in a superior loblolly orchard at Magnolia Springs (Figure 10).

Both Pydrin and Ambush effectively reduced coneworm and seedbug damage on test trees in Texas (Table 7). The U.S. Forest Service plans to continue testing these pyrethrin insecticides during 1980 in order to obtain sufficient efficacy data for EPA registration.

Late in the summer of 1979, heavy infestations of sucking insects were observed on many study

Figure 10. Pyrethrin insecticide sprays being applied to a loblolly pine at Magnolia Springs to evaluate their efficacy for insect control.

trees treated with pyrethrins at Magnolia Springs. These insects remain to be positively identified, but the two most abundant species were a wooly pine scale, probably *Pseudophillippia quaintancia* Cockerell, and a mealy bug, probably *Oracella acuta* (Lob.). Visual observations revealed that check trees supported low numbers of these sucking insects, trees receiving low concentrations of Pydrin were generally heavily infested and trees treated with Ambush were free of sucking insects (Table 7). Despite this adverse side effect, these insecticides appear to offer considerable promise for seed orchard pest control.

Bark Beetle Research

The Pest Control Section's applied research program on the southern pine beetle (SPB) was limited to a single infestation near Conroe during 1978 in which beetle populations, landing and attack rates were monitored intensively throughout the summer. In 1979, due to a lack of study areas (SPB infestations) in East Texas, investigations were shifted to a variety of field studies on *Ips* bark beetles.

Table 7. Insect damage and levels of scale infestations in Ambush®and Pydrin®insecticide test in the Magnolia Springs superior loblolly orchard (1979).

Treatment	Percent *Dioryctria* infested cones[1]	Percent seedbug damaged seed	Mean scale insect infestation index[2]
Ambush 0.15%	1.4[a]	trace	1.0
Pydrin 0.05%	2.0[a,b]	0	2.6
Pydrin 0.025%	4.0[b,c]	0	3.4
Pydrin 0.0125%	5.1[c]	0	3.4
Check	12.7[d]	2.7	2.2

[1]Any two means not having a letter in common are significantly different at the 5% level.

[2]The scale insect infestation level on each test tree was determined from visual inspections of foliage and classified into the following categories: 1 = none, 2 = <50% of branches with scale insects present and some sooty mold present, 3 = >50% of branches with few to many scale insects present and many branches with sooty mold, 4 = most branches with numerous scale insects and sooty mold.

SPB Brood Distribution and Spot Growth Trends

A large southern pine beetle spot located near Conroe was monitored at 3-week intervals from May 11 until August 24, 1978. The spot was located in a loblolly pine stand having an average DBH of nine inches and a basal area of 130-180 sq. ft./acre. Over this time interval, a direct relationship was observed between the proportion of active trees with fresh SPB attacks (attacking adults and/or eggs) and subsequent spot growth trends (Figure 11). These data suggest that the distribution of brood stages within a spot may be a useful indicator of future spot growth trends during summer months. When more than 30 percent of the active trees are fresh attacks, the total number of active trees in the spot is likely to increase in the next few weeks if stand conditions remain uniform. Similarly, when fresh attacks represent less than 30 percent of total active trees, the beetle activity in the spot is declining. A static spot is one in which new trees are being attacked at the same rate as brood trees are being abandoned by emerging beetles. Such a spot averages 30 percent of active trees with fresh attacks, 40 percent with larvae and 30 percent with pupae and/or new adults. These trends would be predictable only in the absence of beetle immigration from other brood sources.

In the Conroe spot, the number of new trees attacked between each observation period from June 1 through August 24 was equal to or less than the number of trees from which beetles had emerged during the same time interval. Apparently, beetle immigration into the spot had largely terminated by June 1 and attacking beetles were originating from within the same spot throughout the summer.

Models of the SPB Attack Process

Two simple mathematical models have been developed to characterize the attack process of the southern pine beetle on loblolly pine. Data for these models were obtained by monitoring landing and attack rates on a daily basis in the 1978 Conroe infestation. The first model predicts the number of beetles which will attack a tree on any given day based on the number of previously-attacking beetles (those producing population-aggregating attractants). The second and more complex model relates both landing beetles and beetles that initiate gallery construction to beetles that are producing attractants in the same tree. The latter model suggests that the rate and duration of SPB attack on individual trees is influenced by host stimulants present in loblolly pine bark. These models should be useful for evaluating the efficacy of behavioral chemicals (synthetic attractants and inhibitors) as potential control tactics. Detailed descriptions of the models are provided in the following reports.

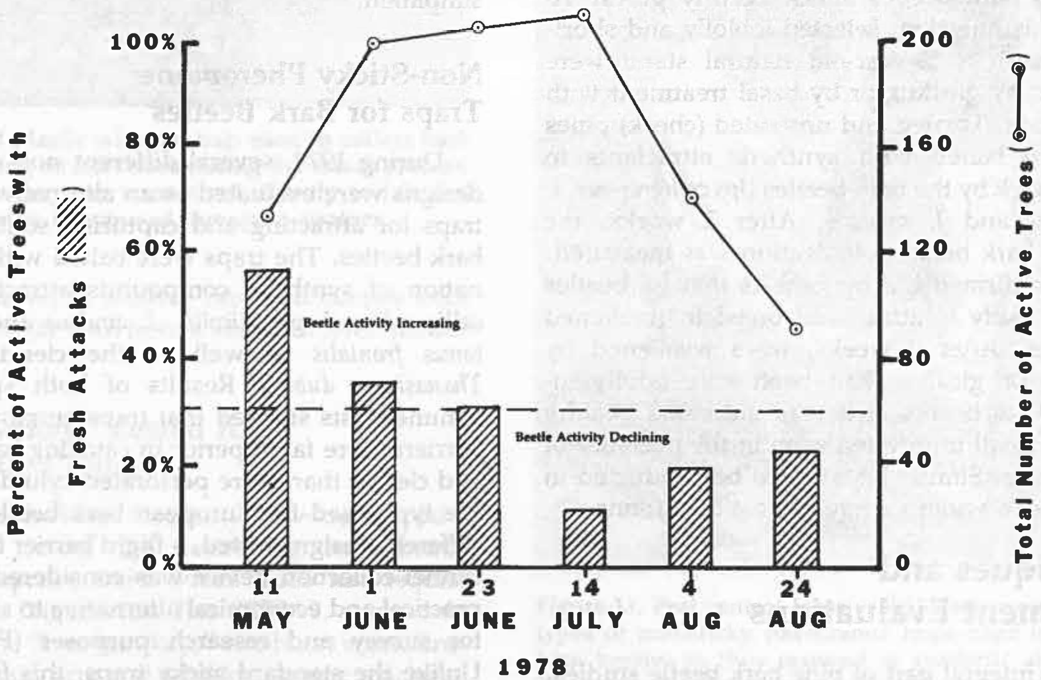


Figure 11. Relationship between percent of active trees with fresh southern pine beetle attacks and subsequent spot growth trends (e.g. changes in number of active trees). Spot monitored during summer 1978 at Conroe, Texas.

Hynum, B. G. 1980. Models of the attack process of the southern pine beetle on loblolly pine. Expanded Southern Pine Beetle Research and Applications Program Symposium on SPB Models (In press).

Hynum, B. G. 1980. *Dendroctonus frontalis* Zimm. (Coleoptera:Scolytidae): Gallery initiation on loblolly pine. Canadian Entomologist (In review).

Changes in SPB Sex Ratios During Attack

In the Conroe spot, the ratio of females to male southern pine beetles landing in flight traps on individual loblolly pines was monitored as the trees became infested. Only minor shifts in the sex ratio were observed throughout the attack process. The mean percent of female beetles in traps started at about 50 percent and declined by less than 1 percent per day over the 7- to 10-day period. This contradicts earlier theories indicating a more significant change in sex ratio during the attack process. Implications of these findings are discussed in the following report.

Hynum, B. G. Changes in the sex ratio of *Dendroctonus frontalis* Zimm. on *Pinus taeda* L. during aggregation. Canadian Entomologist (In review).

Influence of Tree Condition on Attacks by *Ips* Bark Beetles

Do *Ips* bark beetles attack healthy pines? To answer this question, selected loblolly and shortleaf pines in a 20-year-old natural stand were weakened by girdling or by basal treatment with an herbicide. Treated and untreated (check) pines were then baited with synthetic attractants to induce attack by the bark beetles (*Ips calligraphus, I. grandicollis* and *I. avulsus*. After 2 weeks, the extent of bark beetle colonization was measured. Results confirmed the hypothesis that *Ips* beetles are most likely to attack and breed in weakened host trees. After 2 weeks, trees weakened by herbicide or girdling had been successfully invaded by *Ips* beetles, whereas untreated healthy trees remained uninfested even in the presence of pheromones. Similar tests are to be conducted in 1980 under a wider variety of host conditions.

Techniques and Equipment Evaluations

As an integral part of pine bark beetle studies, the Pest Control Section has designed and tested more efficient methods of trapping in-flight beetle populations. Also, during 1978, a mechanical debarking device was tested to evaluate its potential for direct control of southern pine beetle.

Window Traps for Monitoring Bark Beetle Landing Rates

In bark beetle research, sticky traps (cardboard or hardware screen coated with sticky adhesive) have been the traditional method to monitor beetles as they land on host trees. One disadvantage of sticky traps is that beetles must be removed one by one or by means of trap cleaning devices. Both methods are time consuming and cumbersome.

To avoid this problem, a relatively simple and inexpensive non-sticky window trap was constructed from a clear plastic shoe box available at variety stores. The sides were cut out leaving a side brace, a thick lower wall for a water trap and an upper shelf for excluding beetles from entering the trap from above (Figure 12a). One of the sections removed from the side of the box was glued with silicone sealer to the base of the trap's frontal opening to hold water. Two holes were cut at the top of the trap for a cord loop for hanging the trap on the tree.

Beetles flying toward the trap hit the clear plastic and drop into the water basin where they remain until collected. Captured beetles are transferred directly to collection vials (Figure 12b) after the water from the trap has been drained through a sieve. In this manner, the task of collecting beetles periodically from landing traps is greatly simplified.

Non-Sticky Pheromone Traps for Bark Beetles

During 1979, several different non-sticky trap designs were evaluated as an alternative to sticky traps for attracting and capturing southern pine bark beetles. The traps were baited with a combination of synthetic compounds attractive to *Ips calligraphus, I. grandicollis, I. avulsus* and *Dendroctonus frontalis* as well as the clerid predator *Thanasimus dubius*. Results of both spring and summer tests showed that traps employing flight barriers were far superior in catching bark beetles and clerids than were perforated cylinder traps of the type used for European bark beetles. Of the different designs tested, a flight barrier trap with a funnel collection device was considered the most practical and economical alternative to sticky traps for survey and research purposes (Figure 13). Unlike the standard sticky traps, this funnel barrier trap can be used to collect live beetles free of contamination by sticky materials. Also, much less

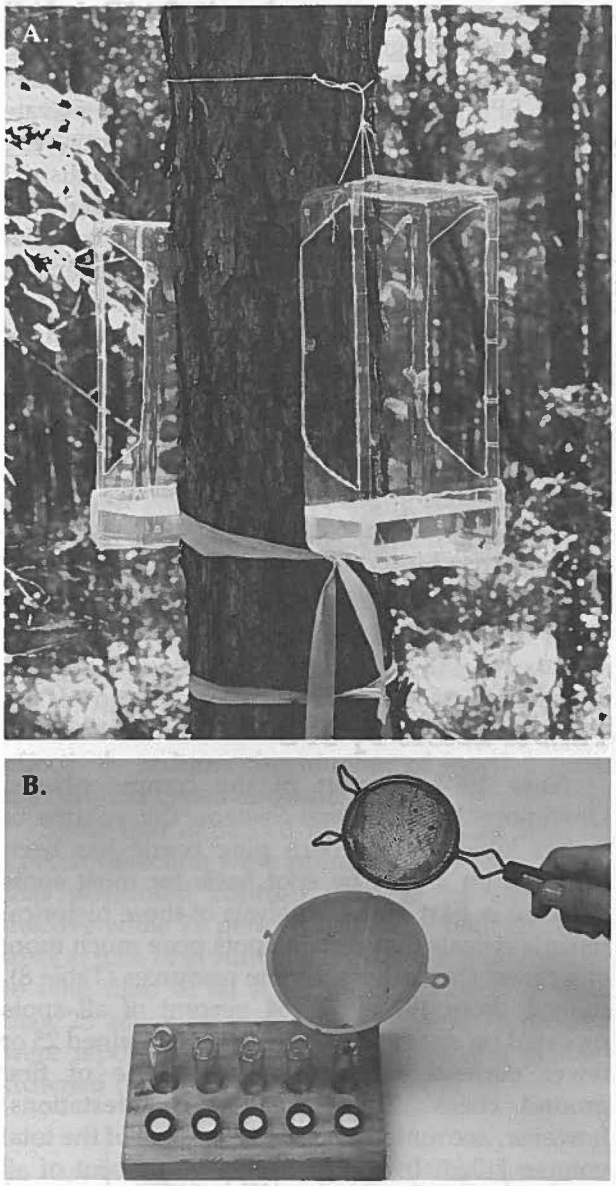


Figure 12. a) Plastic window trap used to collect bark beetles landing on host trees during the attack process. b) Beetles in trap are transferred directly to labelled vials after water is removed through a strainer.

time is required to remove captured beetles from the collection jar than from a sticky-covered barrier trap.

"Tree Monkey" Tested for Bark Beetle Control

Scientists in West Germany have developed a mechanical device for destroying bark beetle broods in spruce trees which does not require felling trees (Figure 14). The SERIAS, commonly known as the "tree monkey," combines a gasoline-powered chain saw and a bark chipping machine. When placed around the base of a beetle-infested tree, the machine automatically climbs and limbs

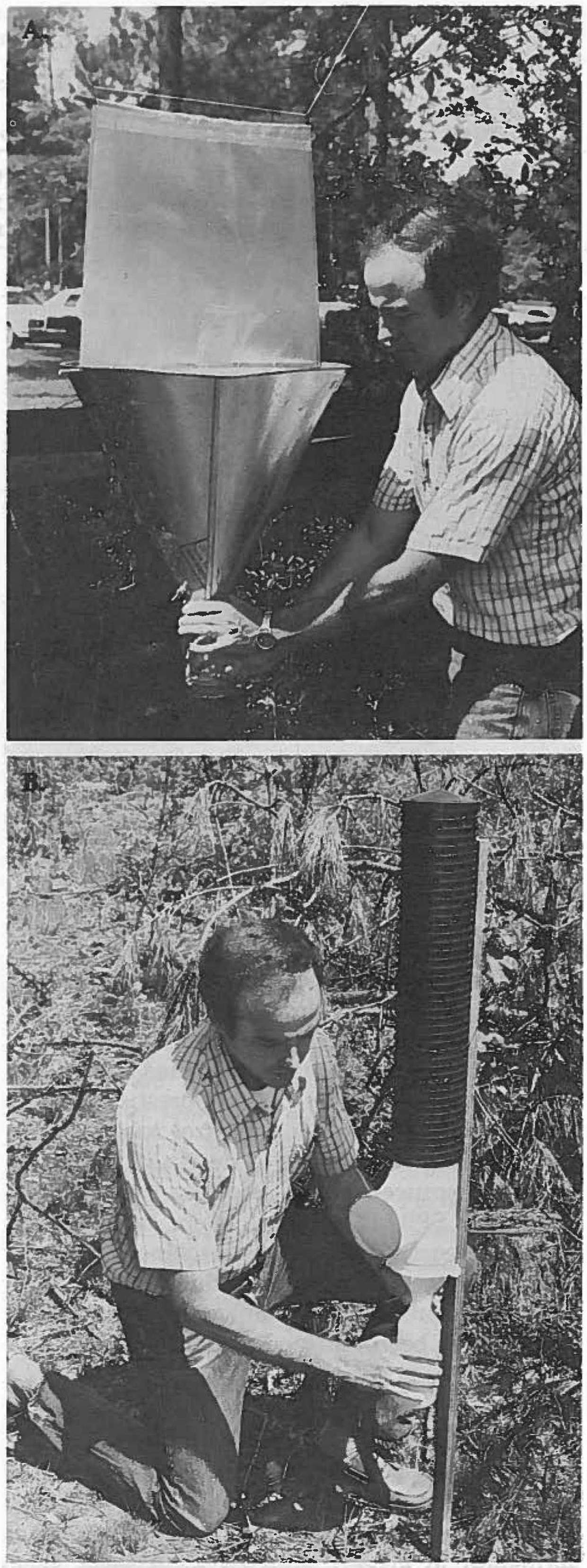


Figure 13. Pest control forester Bill Rose examines two types of non-sticky pheromone traps used to capture bark beetles as they respond to synthetic attractants. The funnel barrier type (a) collected many more beetles than the perforated cylinder trap commonly used in Europe (b).

Figure 14. The SERIAS, or tree monkey, in operation on a standing beetle-infested pine in East Texas.

the infested bole to a predetermined height. As it returns to the ground, chipper blades completely remove infested bark from the bole of the tree, pulverizing bark beetle broods in the process.

In 1978, Frieburg University loaned a prototype of the machine to the Texas Forest Service to evaluate its potential as a control tool for SPB. Unfortunately, the device — designed for use on thin bark spruce trees — did not function adequately on SPB-killed pines. Major modifications would be required before this machine could be of practical use on southern pines due to their thicker bark and more crooked trunks. As a result, the machine has been returned to Germany.

SPB Control — Trends from Historical Records

Description of the Operations Informational System

In 1973, the Texas Forest Service and major industrial landowners in East Texas initiated a computer-based data management system for southern pine beetle operations. This "Operations Informational System" (O.I.S.) consists of a series of computer programs for processing and summarizing detection, ground check and control data for all SPB spots recorded on state and private forest lands. In addition to other output, the system provides biweekly printouts to TFS district and industry field units listing the control status of all infestations within their administrative boundaries. The system also provides a comprehensive data bank in a form suitable for electronic data processing. These records have proved useful for monitoring spatial and temporal patterns of infestations on an area-wide basis and for evaluating the efficacy of current control tactics. A detailed description of this informational system is provided in the following publication:

Pase III, H. A. and E. P. Fagala. 1980. A computer-based informational system to aid southern pine beetle control operations. Texas Forest Service Publ. 120. 21 pp.

Influence of Spot Size on Timber Losses by SPB

Since 1974, as part of the computer-based Operations Informational System, the volume of timber killed by southern pine beetle has been recorded on a spot by spot basis for most spots detected in East Texas. Analysis of these historical records reveals that certain spots pose much more of a threat than others to pine resources (Table 8). Indeed, from 1974-1977, 64 percent of all spots reported on state and private lands contained 25 or fewer currently-infested trees at time of first ground check. These small-sized infestations, however, accounted for only 22 percent of the total volume killed. In contrast, only 20 percent of all spots contained more than 50 active trees. These large spots, although few in number, collectively resulted in more than 60 percent of the total volume of timber killed by SPB. Large spots not only contain more dead timber at time of detection, but, unlike many small spots, they are likely to expand during warm months if not controlled, resulting in excessive timber losses.

Relationship Between Aerial and Ground Estimates of Spot Size

During SPB operations, aerial observers set ground check priorities primarily by estimating the relative size of suspected SPB spots they observe from an airplane. This estimate is based on the number of red- and yellow-crowned trees visible in the spot. Due to the 4-6 week lag time required for the crowns of infested trees to discolor, this estimate does not always reflect current levels of

Table 8. **Distribution of spot sizes by frequency of occurrence and proportion of total timber volume killed over a 4-year period in East Texas (Source: Texas Forest Service operational records 1974-1977).**

Spot size (active trees)	Number of spots with volume data	Percent of total spots	Volume of timber killed (cu. ft.)	Percent of total volume
0-25	9776	63.9	9,358,590	22.5
26-50	2476	16.2	6,633,522	16.0
51+	3039	19.9	25,591,092	61.5
TOTAL	15,291	100	41,583,234	100

beetle activity in the spot. An analysis of ca. 7,000 spot records from East Texas for the period 1974-1977 reveal that, on the average, the relationship between aerial and ground estimates is best for very large and very small spots (Figure 15). Of spots that appeared to contain one to nine affected trees from the air, 87 percent contained 10 or fewer active trees when ground checked within 30 days. For the most part, these small spots were either inactive or required no control. For this reason, the Texas Forest Service now reports only those spots that contain 10 or more affected trees. This practice effectively reduces the number of inactive spots that ground crews encounter.

Spots that appeared to contain more than 25 trees at detection were primarily very active spots that warranted control; only 19 percent were inactive while 73 percent had more than 25 active trees at time of ground check. Also, it is interesting to note that, of all spots found to contain more than 25 active trees at ground check, 76 percent were reported with 11 or more red and yellow-crowned trees at detection.

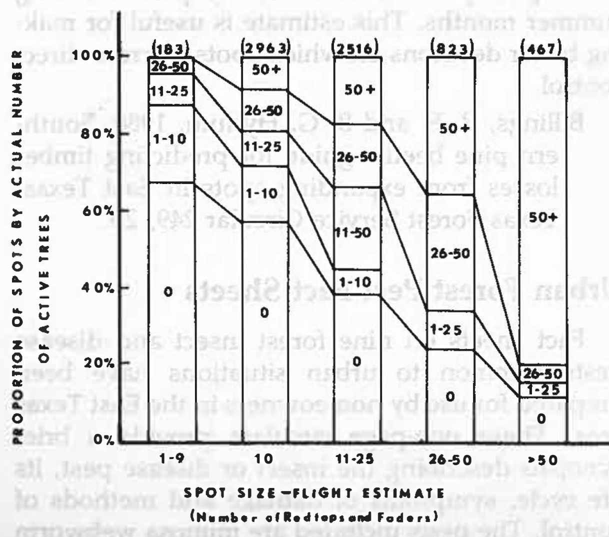


Figure 15. Relationship between aerial estimate of spot size and actual number of active (southern pine beetle-infested) trees present at time of ground check. All spots ground checked within 30 days of detection. (Source: Texas Forest Service operational records for May-October 1974-1977).

Time Lags to SPB Control

The principal tactics currently recommended for control of SPB are salvage and cut-and-leave. Where a market exists for beetle-killed trees and the spot is accessible, salvage is the most recommended tactic because the landowner can recover some of his losses by selling the timber. But a major disadvantage of salvage for large landowners faced with numerous spots to control is the longer time lag required to apply this procedure. Records for controlled spots on state and private land in East Texas during 1975 reveal an average delay of 33 days between date of first ground check and control by salvage (Figure 16). By contrast, cut-and-leave was applied within an average of 3 days after spots were ground checked. During 1976, when nearly 11,000 spots were detected, the lag time between ground check and control averaged 43 days for salvage and 14 days for cut-and-leave. Lag time to salvage control generally increased with spot size and delays were longer on small private lands than on industrial lands.

This delay in control is an important constraint for area-wide control programs because fewer spots can be treated in a given time period. The delay in control also increases timber losses, because uncontrolled spots may continue to expand each day that control is delayed. For every 30-40 days control is postponed during warm months, the southern pine beetle completes one full generation and expanding spots may double in size.

The inherent delay in salvage control is attributable to a number of factors. Locating buyers for the timber, transporting heavy equipment among spots, unpredictable ground conditions, felling and removal of trees no longer containing beetles all combine to slow down salvage operations. Cut-and-leave, by contrast, is often applied at the time of first ground check, with little or no delay involved. If prompt control of numerous infestations is the goal, it is recommended that expanding spots be treated first with cut-and-leave to prevent further timber losses. Merchantable timber in these spots can be scheduled for later salvage when time and ground conditions permit.

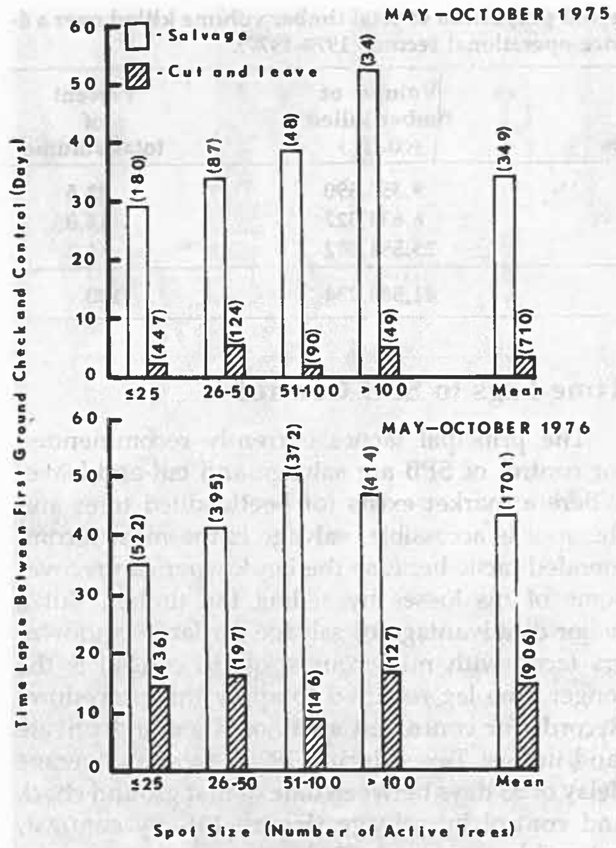


Figure 16. Average time lapse interval from first ground check of SPB spots to control by salvage versus cut-and-leave during moderate (1975) and severe outbreak (1976) years in East Texas. Numbers in parentheses represent total spots reported. (Source: Texas Forest Service operational records.)

Pest Control Field Guides and Publications

The Pest Control Section, responsible for providing guidance and training to state and private field crews, has prepared three field guides to aid SPB control operations. Two have been published as U.S. Department of Agriculture Handbooks, in cooperation with the U.S.D.A's Expanded Southern Pine Beetle Research and Applications Program, for use throughout the South.

SPB Aerial Observer's Guide

This color-illustrated field guide is designed to help foresters and technicians become efficient aerial observers. It has two sections. First, it describes how SPB spots appear from the air in the summer — the season when most new infestations are detected — and explains how to distinguish them from areas with trees dead or dying from other causes. The discussion includes guidelines for assigning a ground check priority to each reported spot. Then, based on seasonal habits of the beetle and on seasonal changes in the appearances of infestations, the handbook describes infestation symptoms to look for in fall, winter and spring.

Billings, R. F. and C. Doggett. 1980. An aerial observer's guide to recognizing and reporting southern pine beetle spots. U.S. Department of Agriculture Combined Forest Pest Research and Development Program. Agriculture Handbook No. 560, 19p.

SPB Ground Check Guide

This handbook, of similar format as the aerial observers guide, features color photos to show how to recognize trees in various stages of SPB attack. We also discuss how to set control priorities on individual spots and how to mark buffer strips for control crews.

Billings, R. F. and H. A. Pase III. 1979. A field guide for ground checking southern pine beetle spots. U.S. Dept. of Agric. Combined Forest Pest Research and Development Program Agric. Handbook No. 558, 19p.

Guide for Predicting Timber Losses to SPB

A guide for predicting timber losses from expanding southern pine beetle spots in East Texas has been prepared. A step-by-step procedure and table of loss projections allow ground check crews to estimate the tree and dollar losses to be expected from spot spread over a 30 day period during summer months. This estimate is useful for making better decisions on which spots warrant direct control.

Billings, R. F. and B. G. Hynum. 1980. Southern pine beetle: guide for predicting timber losses from expanding spots in East Texas. Texas Forest Service Circular 249, 2p.

Urban Forest Pest Fact Sheets

Fact sheets on nine forest insect and disease pests common to urban situations have been prepared for use by homeowners in the East Texas area. These one-page circulars provide a brief synopsis describing the insect or disease pest, its life cycle, symptoms of damage and methods of control. The pests included are mimosa webworm and mimosa wilt (Circular 228), pine webworm (Circular 239), fall webworm (Circular 240), sawflies (Circular 241), bagworms (Circular 242), elm leaf beetle (Circular 243), fire ants (Circular 244), and iron chlorosis (Circular 245).

Other Recent Publications

Results from a number of recent Pest Control Section research studies discussed in the 1976-1977 Pest Control Biennial Report are now available in published form as follows:

Billings, R. F. and C. A. Kibbe. 1978. Seasonal relationships between southern pine beetle brood development and loblolly pine foliage color in East Texas. *Southwestern Entomologist* 3(2): 89-95.

Vité, J. P., G. Ohloff and R. F. Billings. 1978. Pheromonal chirality and integrity of aggregation response in southern species of the bark beetle *Ips* sp. *Nature* 272:817-818.

Billings, R. F. and H. A. Pase III. 1979. Spot proliferation patterns as a measure of the area-wide effectiveness of southern pine beetle control tactics. *In* Evaluating control tactics for southern pine beetle: Symposium Proceedings p. 86-97. J. E. Coster and J. L. Searcy, eds. USDA Tech. Bull. 1613.

Billings, R. F. 1979. Detecting and aerially evaluating southern pine beetle outbreaks-operational guides. *Southern Journal of Applied Forestry* 3(2): 50-54.

Hedden, R. L. and R. F. Billings. 1979. Southern pine beetle: factors influencing the growth and decline of summer infestations in East Texas. *Forest Science* 25: 547-566.

Pest Control Staff

The Forest Pest Control Section consists of the following full-time staff members:

Dr. Ronald F. Billings — Principal Entomologist
Dr. Barry G. Hynum — Entomologist III
Mr. Herbert A. Pase III — Entomologist II
Mr. R. Scott Cameron — Entomologist II
Mrs. Eva P. Fagala — Technician I
Mr. F. Alan Smith — Technician I
Ms. Amy L. Nystrom — Technician I
Mrs. Martha L. Johnson — Secretary

Michael R. Jeter, a technician with the Section since September 1977, left in December 1979 to join Borden Chemical Company in Diboll. After a little more than one year with the Section, William F. Rose III transferred in July 1979 to TFS District 7 in Nacogdoches. Bill now serves as forester for Angelina County.

Amy L. Nystrom joined the Section in January 1980 as a Technician I, replacing Mike Jeter. She holds a bachelor's degree from Stephen F. Austin State University. Amy will be assisting primarily with research on cone and seed insects. F. Alan Smith, a member of the staff since 1973, was promoted to Technician I in September 1979.